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Production of protein pea grain provides a valuable feed ready for direct utilisation at one's own farm. Due to a low level of anti-nutritional factors, protein pea grain is used in animal feeding without any previous heat treatment. Digestible energy of protein pea in utilisation by pigs is high and there is no negative correlation between the protein level and its energy value. Standardised ileal digestibility of proteins in pigs is 82%, while its value for lysine is about 85%. When utilized by poultry, pelleted protein pea can be incorporated up to a level of 20% for laying hens and at a level of 25% or 30% for broilers and turkeys, with protein digestibility of 85%. Protein pea grain can be incorporated in diets for ruminants in high daily doses, increasing both milk production and growth. A coarse grinding of pea grain decreases protein degradability in the rumen and loss of energy.

**Key words:** animal feeding, protein pea, green forage, grain, protein content.

### Introduction

Pea is one of the most important crops in the temperate climatic regions for both human consumption and animal feeding. As a forage plant, pea is grown alone or in mixtures with small grains and is used in the form of green forage, hay, silage, haylage, dehydrated feed and grain, as well as in the form of green manure.

In a botanical sense, the term *protein pea* designates the variety *sativum* of the subspecies *sativum* of the species *Pisum sativum* L., while the term *forage pea* is used for the variety *arvense* as well (Mihailović *et al.*, 2004b). In an agronomic sense, the term *protein pea* (also *feed peas* in English and *pois protéagineux* in French), designates the pea cultivars for grain with white flowers and white-yellow or blue-green seeds. The cultivars with violet flowers and coloured seeds rich in tannins are grown in Australia and Eastern Europe, while the cultivars with wrinkled seeds are not used in animal feeding. Of special importance are the cultivars with afila leaf type, because of high tolerance to lodging and yields not lower than in the cultivars with normal leaf type (Mihailović *et al.*, 2005b). The term *forage pea* is used for the cultivars with whole plant used (Mihailović *et al.*, 2005a).

### Protein pea in the world and Serbia and Montenegro

The world production of protein pea grain is  $12.1 \cdot 10^6$  t on the area of  $6.8 \cdot 10^6$  ha. The greatest producers are Canada ( $3.3 \cdot 10^6$  t), China ( $1.35 \cdot 10^6$  t), Russia ( $1.1 \cdot 10^6$  t), India ( $0.8 \cdot 10^6$  t) and USA, Australia and Ukraine ( $0.5 \cdot 10^6$  t each). In the European Union, protein pea is grown on  $0.9 \cdot 10^6$  ha, with a production of  $3.0 \cdot 10^6$  t (FAO, 2004). The main producers within the European Union are France ( $1.67 \cdot 10^6$  t), Germany ( $0.37 \cdot 10^6$  t), United Kingdom ( $0.29 \cdot 10^6$  t), Spain ( $0.18 \cdot 10^6$  t), Denmark ( $0.11 \cdot 10^6$  t) and Austria ( $0.10 \cdot 10^6$  t).

During the last two decades, protein pea became an important factor of animal husbandry in former Yugoslavia (Mihailović and Mišković, 1987). Foreign cultivars were successfully replaced by the first domestic ones, all of whom were developed in the Institute of Field and Vegetable Crops in Novi Sad. Among cultivars for green forage and hay, the most widely distributed is the winter cultivar NS-Pionir; among the cultivars for both forage and grain, it is the spring cultivar NS-Junior; and, among the cultivars for grain, it is the spring cultivars Jezero and Javor (Mihailović *et al.*, 2004c). Novi Sad spring protein pea cultivars have a potential for more than  $30 \text{ t ha}^{-1}$  of green forage (Mihailović, 1991) and more than  $5 \text{ t ha}^{-1}$  of grain, with a crude protein content in grain of between 25% and 28 % (Mihailović *et al.*, 2003b). It is estimated that protein pea, together with vetches, is grown on between 30,000 ha and 35,000 ha in Serbia and Montenegro.

1 Review paper – pregledni rad

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*Chemical composition of protein pea*

Dry matter of protein pea forage contains lower crude protein content than in vetches, lucerne and sainfoin. It is mainly because of breeding that crude protein content in dry matter of forage in the protein pea cultivars of later generations is higher than 20%. If pea is grown in mixtures with small grains, the richest in crude proteins is the forage of mixture of pea and wheat (Table 1).

Table 1. Crude protein content ( $\text{g kg}^{-1}$  DM) in dry matter of Novi Sad forage pea cultivars and their mixtures with small grains (Mihailović *et al.*, 2004a)

Cultivar	Single	With wheat	With barley	With oats
NS-Pionir	197	167	136	141
NS-Dunav	201	151	137	138
NS-Lim	237	199	154	169

Table 2. Chemical composition (% as fed) of grain in pea, wheat and soya bean (ITCF *et al.*, 1996)

Species	Pea	Wheat	Soya bean
Proteins	21.0	11.3	45.7
Starch	43.9	59.3	3.0
Soluble carbohydrates	4.6	2.9	9.0
Fats	1.5	2.1	2.0
Ash	3.0	1.6	6.2
Insoluble cell walls	12.5	10.2	13.2
Crude fibres	5.2	2.2	5.3
NDF	9.8	7.7	12.3
ADF	5.8	3.1	7.7
Lignin	0.9	1.0	0.6

Portion of dry matter in protein pea haylage is between 34% and 44%. Crude protein content of dry matter of haylage ranges from 16.8% to 17.9%, with a crude fibre content of between 25.3% and 28.2% (Negovanović *et al.*, 1996).

Protein pea grain consists mostly of starch and proteins, both of which are highly digestible. Crude fibre is contained mainly in the seed coat. By its content of crude proteins, starch, soluble carbohydrates, ash and acid and neutral detergent fibre (NDF and ADF), protein pea grain is intermediary between that of cereals and soya bean (Table 2). Protein content depends on cultivar and climatic conditions and varies within most commercial cultivars between 20% и 27% on dry matter bases, that is between 17% and 23% as fed.

Proteins in pea grain are especially rich in lysine. Its portion in crude protein content in pea grain is higher than in crude protein content in soya bean. Lysine content in pea grain is 2.04% DM and 2.72% DM in soya bean meal (Šibalić *et al.*, 1985). Since proteins in pea grain contain inadequate levels of tryptophan and the sulphur amino acids, formulation of well balanced diets with cereals and pea for non-ruminants often require the addition of small quantities of synthetic amino acids.

Protein pea grain contains proteinaceous anti-nutritive factors, mainly trypsin inhibitors and lectins, at a level that is rather low in comparison with other grain legumes. In that way, utilisation of pea grain in animal feeding does not require heat treatments (Mihailović *et al.*, 2003a).

*Utilisation of protein pea by pigs*

Digestible energy of protein pea grain of  $14.1 \text{ MJ kg}^{-1}$  is considered high and relatively stable (UNIP and ITCF, 1995a). At the same time, there is no negative correlation between the protein content and its energy value. Standardised ileal digestibility of pea proteins is about 82%, being somewhat lower than in proteins of wheat and soya bean. On the other hand, standardised ileal digestibility of lysine, as the most important amino acid, is 85% and is regarded as relatively high. Due to a high content of digestible lysine in pea grain, it is possible to formulate balanced diets with a low protein level and thus reduce the amount of nitrate excreted and minimise environmental pollution.

In case the protein level in diets is not balanced, the level of pea in diets for weaning piglets must be limited to 10% (Kovčín *et al.*, 1996); otherwise, the level of pea can be increased up to 30%. In that way, pea grain can replace soya bean meal completely (Mihailović *et al.*, 2003c). When used by growing finishing pigs, pea can be incorporated at a significantly higher level of 30%, depending on the balance of amino acids in diets. An inadequate level of essential amino acids decreases the food conversion ratio and the percentage of muscle. In the event of diets containing adequate amounts of methionine and tryptophan, often the two most limiting amino acids, the pea level can be increased up to 45% or even without limits (Grosjean *et al.*, 1991). There are no limits in utilisation of pea by sows as well (Gatel *et al.*, 1987).

#### *Utilisation of protein pea by poultry*

The value of metabolisable energy of pea in diets for poultry is 11.1 MJ kg<sup>-1</sup> (Lacassagne, 1988), with a protein digestibility of 85% and a starch digestibility of 98%. Pelleting is responsible for the improvement and homogenisation of digestibility, especially in young birds (Conan *et al.*, 1992). As in diets for pigs, there is no negative correlation between the protein content and its energy value in diets for poultry either.

Inclusion of pea at a level of 25% in diets for broilers has a positive effect on growth, but only if energy, proteins and essential amino acids in mixtures are balanced (Supić *et al.*, 1996). Although there are reports that it is possible to incorporate pea in diets for laying hens at a level of 30%, it is recommended that the limit of inclusion of pea should be 30%, to avoid reductions in egg weight (UNIP and ITCF, 1995b). The suggested limit of inclusion of pea into diets for turkeys is 20%, due to a slightly reduced growth (Horst and Maitre, 1988).

#### *Utilisation of protein pea in ruminants*

Pea forage has high biological value and can be successfully used by ruminants. Dry matter of pea forage has the net energy of lactation between 25,000 MJ ha<sup>-1</sup> and 29,000 MJ ha<sup>-1</sup> and net energy of maintenance between 24,000 MJ ha<sup>-1</sup> and 28,000 MJ ha<sup>-1</sup> (Pejić *et al.*, 1997).

Protein pea grain has the same value of metabolisable energy as soya bean meal, 11.6 MJ kg<sup>-1</sup>, as well as the milk and meat forage units of 4.18 MJ kg<sup>-1</sup> each (UNIP and ITCF, 1997). Although pea proteins are mostly digested in the rumen, providing that only small amount of proteins reach the small intestines, it is possible to decrease protein degradability in the rumen by a coarse grinding (Michalet-Doreau and Cerneau, 1991).

Soya bean meal in diets based upon maize silage for beef cattle (Weiss and Raymond, 1989) and dairy cows (Sretenović *et al.*, 1996) can be completely replaced by pea. In beef cattle, the quantities of pea of 2.5 kg (less than 300 kg live weight) and 2.0 kg (more than 300 kg live weight) are recommended. The daily dose of pea for dairy cows producing between 25 kg and 30 kg of milk daily is 6.5 kg (Hoden *et al.*, 1992). Pea is fed to sheep mostly in the form of pellets with a mineral or vitamin premix or as whole grains mixed with premix (Cazes, 1989). As a high protein supplemental feedstuff, pea can be incorporated in diets for goats as well (Pinkerton and Pinkerton, 2005).

#### *Utilisation of protein pea by other domestic animals*

Pea may be incorporated into diets for growing rabbits at a level of 30% by replacing all of the soya bean meal, thus improving both reproductive performances and food conversion rates of females and reducing mortality (Seroux, 1988).

If the quality of hay and straw is poorer, pea grain is used as a protein supplement for horses, especially for young, growing animals (Johnson, 2001).

Inclusion of pea grain, as the most important legume feed, into diets for racing pigeons is from 10% to 15% (Hermans, 1986).

High-quality protein sources, such as peas, may be used as a feed ingredient for a high-profit, high-demand fish such as yellow perch, where a level of 20% of pea grain results in the highest weight gains and feed conversion ratio (Jarvis, 2005).

Pea plants represent a quality feed for raising snails (Thompson and Cheney, 1996), especially if the cultivars for green forage with high portion of leaves in plant mass are grown.

## PROTEINSKI GRAŠAK U ISHRANI DOMAĆIH ŽIVOTINJA

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### Rezime

Proizvodnjom zrna proteinskog graška se dobija vredna stočana hrana spremna za neposredno korišćenje na sopstvenom gazdinstvu. Usled niskog sadržaja anitnutritivnih materija zрно proteinskog graška se koristi u ishrani domaćih životinja bez prethodne termičke obrade. Svarljiva energija proteinskog graška u ishrani svinja je visoka i ne postoji negativna korelacija između sadržaja proteina i njihove energetske vrednosti. Standardizovana svarljivost proteina kod svinja je 82%, a lizina 85%. Proteinski grašak u obliku peleta u ishrani živine može da učestvuje sa manje od 20% kod koka nosilja i sa 25 ili 30% kod brojlera i ćurki, uz svarljivost proteina od 85%. Zrno proteinskog graška može da se uključuje u obroke za preživare u visokim dnevnom dozama čime se povećava mlečnost i prirast. Grubo mlevenje zrna graška smanjuje razgradljivost proteina u rumenu i gubitak energije.

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